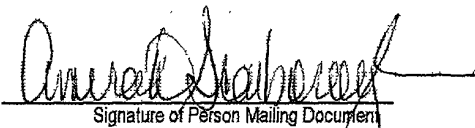


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## METHOD AND SYSTEM FOR OBJECT ORIENTED APPROACH AND DATA MODEL FOR CONFIGURE-TO-ORDER MANUFACTURING SYSTEM

### FIELD OF THE INVENTION

The present invention relates to automated product fulfillment and in particular, an object oriented approach and data model for configure-to-order computer manufacturing systems.

### BACKGROUND OF THE INVENTION

The computer manufacturing industry has undergone several major changes in recent years. One of these major changes has been in the area of customized or personalized computer systems. Today, consumers essentially can build their own systems based on their unique requirements. For example, a customer can select hardware components (e.g., types and quantities of memory, DASD, CPU, PCI option cards, etc.), and the placement of the hardware within the system (e.g., which slots, bays, and riser cards the devices are installed in and how they are cabled). Moreover, the customer can select software (e.g., operating systems, applications, and device drivers), system settings (e.g., boot sequence, RAID configuration, and operating system and network settings such as computer name, IP addresses, subnet masks, etc.), and other services

(e.g., placement of asset tags on exterior of machines, saving and printing information unique to the machine). Thus, the customer can build a configure-to-order system that meets the customer's exact specifications and requirements.

Providers of configure-to-order fulfillment systems face numerous challenges. First, given the variety of hardware components, software, settings, and services available in a computer system from which the customer might choose, the configure-to-order system must be able to handle the various permutations created by the customer. Because of the enormity of this task, current configure-to-order systems do not afford the customer full control over customization. Rather, a "machine type model" approach is taken, wherein a grouping of components is represented by a part number or model name. For instance, a particular part number might signify a specific CPU with memory loaded in a particular slot. The manufacturing system understands the meaning of the part number and builds the corresponding product. In this approach, the customer is allowed a limited range of predetermined choices, such as processor type, memory, and perhaps exterior color. Accordingly, while the number of combinations is manageable for the provider, customer flexibility is sacrificed.

In the alternative, custom preferences can be communicated to a customer service provider who then records or enters the information on an order form (text based), which is then used during the post ordering process. This system, however, is inefficient because the information on the order form might be inaccurate or incomplete, or both, thereby causing delays in manufacturing while the customer is contacted for more information. In addition, the information on the order form must be retyped or otherwise recreated for use in other processes besides assembly, such as testing and software preload. Moreover, if the assembly process is manual, an assembly worker can misinterpret the information on the order form.

Thus, current configure-to-order manufacturing systems either lack the versatility to allow a customer to have full control of the ordering process, or are inefficient in their operations, requiring extensive customer contact after the initial order time. What is needed is a configure-to-order manufacturing system and process which allows the customer flexibility at the initial order time so the customer can choose all of the configuration and personalization options for the product. The system and process should automatically capture this information and create a product plan that meets all of the development rules for the product and installed options and software for correct operation. Moreover, the product plan should describe to the assembly worker what steps must occur to build the product, preferably in a simple picture based manner, describe to the automated test system the configuration of the machine for verification purposes, i.e., to validate the worker correctly assembled the machine and that the parts are functioning correctly, and describe to the automated preload system the software and personalization that must occur. Finally, the product plan should provide information that can be used by service and support for repairs or maintenance. The present invention addresses such a need.

## SUMMARY OF THE INVENTION

A method and system for product fulfillment in an automated manufacturing system is disclosed. The method and system of the present invention includes obtaining requirements for a product from a customer. The method and system further includes creating a plan from the requirements using a descriptive language. The plan is then conveyed to an automated manufacturing system for use in manufacturing the product.

An object oriented approach and data model of the present invention allows customization and personalized information to be captured completely and accurately at the initial order time such that follow-up calls to the customer are eliminated or greatly reduced. Moreover, the present invention provides an end-to-end automated process which enables a manufacturer to build the customized product in a high-quality, cost-effective and repeatable manner.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a block diagram representing a product fulfillment system in accordance with one embodiment of the present invention.

Figure 2 illustrates the product fulfillment process according to the present invention.

**DETAILED DESCRIPTION**

The present invention relates to automated product fulfillment and in particular, to an object oriented approach and data model for configure-to-order product manufacturing systems. The following description is presented to enable one of ordinary skill in the art to make and use the invention and is provided in the context of a patent application and its requirements. Various modifications to the preferred embodiment and the generic principles and features described herein will be readily apparent to those skilled in the art. Thus, the present invention is not intended to be limited to the embodiment shown but is to be accorded the widest scope consistent with the principles and features described herein.

The object oriented approach and data model of the present invention provides the means for capturing customized order information in a clear, non-ambiguous, structured, and extensible manner, and for manufacturing the product in a high-quality, cost-effective, and repeatable manner. Although the following discussion is directed primarily to configure-to-order computer systems, it is important to note that the present invention can be implemented for products other than computers. Thus, the present invention is in no way limited to computer or information processing products.

The object oriented approach and data model of the present invention addresses the problems associated with configure-to-order manufacturing systems discussed above. By using a descriptive language referred to as Architected Object Data ("AOD") to describe the custom ordered product, the manufacturing process from start-to-finish can "speak" the same language. The present invention merges customer requirements, population rules (e.g., sequences for filling CPU, memory, expansion card, DASD slots, etc.) and configuration rules (e.g., setting jumpers,

changing CMOS setup values, etc.) into an accurate and comprehensive product plan that can be passed onto, and used by, an automated manufacturing system.

As will be described in detail below, AOD is a descriptive language that can be used as a data model for personal computers or other systems. The product plan, also known as a process AOD, describes fully every aspect of the product, from the hardware components to the types of connections between devices. Each process downstream from the ordering process understands AOD and uses the product plan to perform its function, whether it be automated testing, software loading, or assembly.

AOD is hierarchical and object oriented in nature. The following is a description of the AOD data model.

### AOD Object Hierarchy

The AOD format provides a hierarchical structure used to describe a product, such as a personal computer. For example, Table 1 illustrates an example of a partial object hierarchy in AOD for a simple personal computer.

TABLE 1

| <u>Level</u> | <u>Object</u>     |
|--------------|-------------------|
| 001          | + - UNIT (1)      |
| 002          | + - CHASSIS(1)    |
| 003          | + - PICTURE (1)   |
| 004          | + - SCHEMATIC(1)  |
| 005          | + - BAYPLANAR (1) |
| 006          | + - PLANAR (1)    |

The "UNIT" object is at the top of the hierarchy, with first level child objects under it. The first level child objects can then in turn be parents to additional levels of child objects. Thus, CHASSIS (1) is a first level child object, and PICTURE (1) is a child of CHASSIS (1). SCHEMATIC (1) and BAYPLANAR (1) are also children of CHASSIS (1), and PLANAR (1) is a child of BAYPLANAR (1).

Because of the modular nature of AOD, new objects can easily be added to the system when new products or components become available. Thus, the customer's choices are continually being updated and optimized.

## General AOD Syntax

AOD uses the following general syntax:

Object(Instance).Attribute = Value

### Object

5           An object in AOD is a model or data template of a component. This template will have attributes that relate to that component (physical or logical). An object or group of objects is chosen to describe each physical part and each logical part. A planar, chassis, PCI cards, memory, and processor are typical physical parts, while software images and partitioning information are logical parts. Thus, for example, an object called "PCI" will be used to represent each PCI device in the unit to be built, and an object called "PLANAR" will be used to represent each planar in the unit.

### Instance

15           The instance of an object is an occurrence of an object. This can also be thought of as a specific usage of an object template. The instance number is a positive whole number starting at 1. It is used to differentiate between multiple occurrences of the same object type. Thus, for example, two different PCI objects will be represented by PCI(1) and PCI(2).



Attribute

An attribute is a characteristic that is associated with an object. For example, attributes associated with a PCI object might be the PCI’s vendor identification and device identification, and whether the PCI is an onboard (soldered) device or an option card.

Value

Each attribute is assigned a value, which is designated by the specific attribute. Thus, the value of an attribute might be a string of text, a number, a comma separated list of numbers or words, as defined by the specific attribute. For example, where an attribute associated with a CPU object might be speed, the value for the speed attribute can be 667\_MHz.

In Table 2, AOD for a CPU device is provided in column 1, and explanative comment is provided in column 2.

TABLE 2

| <u>AOD</u>                    | <u>Comment</u>  |
|-------------------------------|---|
| CPU(1).Desc=Intel P3          | Description of the object                                 |
| CPU(1).BOM_PN=09N9215         | Part number of the object                                 |
| CPU(1).TestClass=cpu          | Indicates type of test that will be done in manufacturing |
| CPU(1).Speed=667_MHZ          | CPU speed information for automated software verify       |
| CPU(1).BusSpeed=133_MHZ       | CPU bus speed information                                 |
| CPU(1).L1Cache=32_KB          | CPU L1 cache information                                  |
| CPU(1).L2Cache=256_KB         | CPU L2 cache information                                  |
| CPU(1).SmbiosType=11          | CPU SMBIOS Information                                    |
| CPU(1).SmbiosDesignation=CPU1 | CPU SMBIOS Information                                    |

### AOD Syntax for Linking Parent and Child Objects

Because AOD is a hierarchical language, it is important to be able to link child objects to their parents using AOD syntax. This is done using the general AOD format, but with a more specific usage of the syntax:

5                                      ParentObject(Instance).ChildObject( ) = Value

#### ParentObject (Instance)

A ParentObject is the object that is being defined to be hierarchically above a ChildObject. The instance is defined above and identifies the parent object specifically.

#### Child Object( )

10                                      The ChildObject is the object that is being defined as being hierarchically below, or owned by the ParentObject. As defined above in the general syntax, the ChildObject occupies the position held by the attribute associated with the ParentObject. The ( ) immediately following the ChildObject is the specific indicator that indicates the attribute is referring to a child object, and that this AOD is linking a parent and child object.

Value

The value in the Parent/Child AOD syntax is a number or range of numbers that indicate which instances of ChildObjects should be linked to the ParentObject.

Table 3 illustrates a sample of AOD for two Parent/Child links.

TABLE 3

PLANAR (1).PCI( ) = 1  
PLANAR (1).ConnectorMem ( ) = 1:2

In the example in Table 3, PLANAR (1) is the parent of PCI (1) object. The second link indicates that PLANAR (1) is the parent of ConnectorMem (1) and ConnectorMem (2).

**AOD Syntax for Describing Device Connections**

It is essential to populate devices such as memory, DASD, CPUs, and option cards, using the correct connectors/cables. Thus, there should be and is a way to model proper connection information in AOD. This is done again using the general AOD format, but with a more specific usage of the syntax:

ReceivingObject(Instance).InstalledDevice=InstalledObject(Instance)

and

ReceivingObject(Instance).LocatedDevice=InstalledObject(Instance)

ReceivingObject(Instance)

The ReceivingObject is the object which will receive an installed or located device. The instance number specifies which occurrence of the ReceivingObject is being referenced.

“InstalledDevice” and “LocatedDevice”

The text strings “InstalledDevice” or “LocatedDevice” are specific attributes indicating that the AOD is describing a device connection and the nature of that connection. InstalledDevice signifies an electrical connection between devices. Typically, devices are electrically connected by cables or connecting members. LocatedDevice indicates that the ReceivingObject and InstalledObject are mechanically or physically connected. So, for instance, LocatedDevice is used to indicate into which bay a DASD device or power supply is physically mounted, and InstalledDevice can indicate into which PCI slot a card will be inserted.

InstalledObject(Instance)

The InstalledObject is the device which is being installed onto the ReceivingObject device. The instance number specifies which occurrence of an installed object is being referenced.

Table 4 is a sample of AOD illustrating device connections.

TABLE 4

```
ConnectorMem (1).InstalledDevice = Mem(1)
ConnectorMem (2).InstalledDevice = EMPTY
BayPower(1).LocatedDevice=Power(1)
BayHdd(1).LocatedDevice = Ide(2)
```

The AOD in Table 4 indicates that ConnectorMem(1) has Mem(1) electrically connected to it, whereas ConnectorMem (2) is empty. ConnectorMem can be a connecting member attached to a device or component. For example, a planar might have several connecting members into which other devices can be installed. Thus, an electrical connection is established between the planar and the device via the connecting member.

Referring back to Table 4, Power(1) power supply is physically mounted in BayPower (1).

The AOD indicates where the power supply is located. DASD Ide(2) is physically mounted in BayHdd(1).

Given these general syntax rules for AOD, a product, such as a personal computer, can be fully and accurately described in a structured and non-ambiguous manner. Table 5 illustrates a complete AOD product plan for a single personal computer with explanatory comments in parenthesis.

TABLE 5

AOD For ORDER\_ID [000100066023]

\*

|   |  |
|---|--|
| UNIT(1).MTM=6565CTO                     | (Machine type and model)                           |
| UNIT(1).BOM_PN=19K5277                  | (Part number for the object)                       |
| UNIT(1).CHASSIS()=1                     | (Indicates there is 1 chassis child object)        |
| UNIT(1).DTAImage()=1                    | (Indicates there is 1 preload image)               |
| UNIT(1).RFIDSUPPORTED=YES               | (Indicates system support rfid functionality)      |
| CHASSIS(1).PICTURE()=1                  | (Indicates there is 1 picture child for chassis)   |
| PICTURE(1).DESC=ATHENA Chassis          | (Description of the picture)                       |
| PICTURE(1).FILE=ATHCHAS.jpg             | (File name of the picture (MFG assembly aid))      |
| CHASSIS(1).SCHEMATIC()=1                | (Indicates there is 1 chassis drawing)             |
| SCHEMATIC(1).DESC=ATHENA Chassis        | (Description of the chassis drawing)               |
| SCHEMATIC(1).FILE=ATHENA1.jpg           | (File name of the drawing (MFG assembly aid))      |
| CHASSIS(1).BAYPLANAR()=1                | (Indicates their is one bay to put a planar)       |
| CHASSIS(1).BAYPOWER()=1                 | (Indicates their is one bay to put a power supply) |
| BAYPOWER(1).LOCATORTEXT=POWER1          | (Text to tell operator how to identify power bay)  |
| BAYPOWER(1).SCHEMATICOFFSET=10,10,30,30 | (Coordinates of power bay on the chassis drawing)  |
| CHASSIS(1).BAYFDD()=1                   | (Indicates there is one bay to put a floppy drive) |
| BAYFDD(1).LOCATORTEXT=FLOPPY DRIVE      | (Text to tell operator how to identify floppy bay) |

BAYFDD(1).SCHEMATICOFFSET=35,40,50,55  
 CHASSIS(1).BAYHDD()=1  
 BAYHDD(1).LOCATORTEXT=HDD BAY1  
 BAYHDD(1).SCHEMATICOFFSET=EMPTY  
 5 CABLEFDD(1).DESC=FDD CABLE  
 CABLEFDD(1).OPERATION=KITTING (Indicates MFG operation that will add part)  
 CABLEFDD(1).BOM\_PN=19K5277  
 CABLEFDD(1).SCHEMATIC()=1  
 CABLEFDD(1).PICTURE()=1  
 10 CABLEFDD(1).CONNECTORFDD()=1  
 CONNECTORFDD(1).FDDTYPE=FDD1  
 CONNECTORFDD(1).LOCATORTEXT=FDD 1  
 CONNECTORFDD(1).DriveName=ADRIIVE  
 CONNECTORFDD(1).SCHEMATICOFFSET=EMPTY  
 15 CHASSIS(1).BAYDASD1()=1  
 BAYDASD1(1).LOCATORTEXT=DASD BAY1  
 BAYDASD1(1).SCHEMATICOFFSET=EMPTY  
 CHASSIS(1).BAYDASD2()=1  
 BAYDASD2(1).LOCATORTEXT=DASD BAY2  
 20 BAYDASD2(1).SCHEMATICOFFSET=EMPTY  
 BAYPLANAR(1).LOCATORTEXT=PLANAR  
 BAYPLANAR(1).SCHEMATICOFFSET=EMPTY  
 PLANAR(1).DESC=ATHENA PLANAR  
 PLANAR(1).OPERATION=KITTING  
 25 PLANAR(1).BOM\_PN=61H2571  
 PLANAR(1).TESTCLASS=athenaplanar (Indicate tests that are associated with this Object)  
 PLANAR(1).CONNECTORCPU()=1 (Indicates there is 1 CPU connector)  
 CONNECTORCPU(1).LOCATORTEXT=CPU 1  
 30 CONNECTORCPU(1).SMBIOSDESIGNATION=CPU (Information on the CPU connector (for SW verify))  
 CONNECTORCPU(1).SCHEMATICOFFSET=EMPTY  
 PLANAR(1).CONNECTORMEM()=1:2 (Indicates there are 2 memory connectors)  
 CONNECTORMEM(1).LOCATORTEXT=MEM 1  
 35 CONNECTORMEM(1).SMBIOSDESIGNATION=DIMM 0 (Information on first memory connector (for SW verify))  
 CONNECTORMEM(1).SCHEMATICOFFSET=EMPTY  
 CONNECTORMEM(2).LOCATORTEXT=MEM 2  
 CONNECTORMEM(2).SMBIOSDESIGNATION=DIMM 1 (Information on the second memory connector)  
 40 CONNECTORMEM(2).SCHEMATICOFFSET=EMPTY  
 PLANAR(1).PCI()=1 (Indicates there is one PCI object on planar)  
 PCI(1).DESC=ESSAUDIOALLEGRO (Information on type of PCI device)

PCI(1).PCIADDRESS=BUS[00]DEV[12]FUNC[0] (Information on address of PCI device)  
 PCI(1).OPERATION=KITTING  
 PCI(1).BOM\_PN=61H2571  
 PCI(1).TESTCLASS=essaudio  
 5 PCI(1).ONBOARD=YES (Indicates PCI is attached to planar (i.e., not a card))  
 PCI(1).VENDORID=125D (Vendor ID for the PCI device (for SW verify))  
 PCI(1).DEVICEID=1988 (Device ID for the PCI device (for SW verify))  
 PLANAR(1).CONNECTORAGP()=1  
 CONNECTORAGP(1).LOCATORTEXT=AGP 1  
 10 CONNECTORAGP(1).SMBIOSDESIGNATION=AGP  
 CONNECTORAGP(1).SMBIOSNAME=PCI  
 CONNECTORAGP(1).PCIADDRESS=BUS[01]DEV[00]FUNC[0]  
 CONNECTORAGP(1).SCHEMATICOFFSET=EMPTY  
 PLANAR(1).CONNECTORPCI()=1:3 (Indicates there are 3 pci connectors on this planar)  
 15 CONNECTORPCI(1).LOCATORTEXT=PCI 1  
 CONNECTORPCI(1).SMBIOSDESIGNATION=1-PCI (Information on first pci  
 connector (for SW verify))  
 CONNECTORPCI(1).SMBIOSNAME=PCI  
 CONNECTORPCI(1).PCIADDRESS=BUS[00]DEV[10]FUNC[0]  
 20 CONNECTORPCI(1).SCHEMATICOFFSET=EMPTY  
 CONNECTORPCI(2).LOCATORTEXT=PCI 2  
 CONNECTORPCI(2).SMBIOSDESIGNATION=2-PCI  
 CONNECTORPCI(2).SMBIOSNAME=PCI  
 CONNECTORPCI(2).PCIADDRESS=BUS[00]DEV[0F]FUNC[0]  
 25 CONNECTORPCI(2).SCHEMATICOFFSET=EMPTY  
 CONNECTORPCI(3).LOCATORTEXT=PCI 3  
 CONNECTORPCI(3).SMBIOSDESIGNATION=3-PCI  
 CONNECTORPCI(3).SMBIOSNAME=PCI  
 CONNECTORPCI(3).PCIADDRESS=BUS[00]DEV[0E]FUNC[0]  
 30 CONNECTORPCI(3).SCHEMATICOFFSET=EMPTY  
 PLANAR(1).CONNECTORCABLEIDE()=1:2  
 CONNECTORCABLEIDE(1).LOCATORTEXT=PRIMARY IDE CONTROLLER  
 CONNECTORCABLEIDE(1).CONTROLLER=PRIMARY  
 CONNECTORCABLEIDE(1).SCHEMATICOFFSET=EMPTY  
 35 CONNECTORCABLEIDE(2).LOCATORTEXT=SECONDARY IDE CONTROLLER  
 CONNECTORCABLEIDE(2).CONTROLLER=SECONDARY  
 CONNECTORCABLEIDE(2).SCHEMATICOFFSET=EMPTY  
 PLANAR(1).CONNECTORCABLEFDD()=1  
 CONNECTORCABLEFDD(1).LOCATORTEXT=FDD CONTROLLER  
 40 CONNECTORCABLEFDD(1).SCHEMATICOFFSET=EMPTY  
 PLANAR(1).CONNECTORPOWER()=1  
 CONNECTORPOWER(1).LOCATORTEXT=POWER INPUT  
 CONNECTORPOWER(1).SCHEMATICOFFSET=EMPTY

PLANAR(1).SCHEMATIC()=2  
 SCHEMATIC(2).DESC=ATHENA Planar  
 SCHEMATIC(2).FILE=ATHPLNR.JPG  
 PLANAR(1).PICTURE()=2  
 5 PICTURE(2).DESC=ATHENA Planar  
 PICTURE(2).FILE=ATHPLNR.jpg  
 PLANAR(1).SETTINGS()=1:2  
 SETTINGS(1).APMBIOS=ENABLE (Indicates CMOS setting requested)  
 SETTINGS(1).ALT\_BOOTSEQUENCE=ENABLE  
 10 SETTINGS(1).RESET\_POC=ENABLE  
 SETTINGS(1).RUNIN=HALF\_HR (Indicates desired test time)  
 IDE(1).DESC=48X CDROM  
 IDE(1).OPERATION=KITTING  
 IDE(1).BOM\_PN=09N0734  
 15 IDE(1).TESTCLASS=cdrom\_aud  
 IDE(1).CAPACITY=48X  
 IDE(1).IDETYPE=CDROM  
 DTAImage(1).DTA\_FILE=BP113US.DTA (Name of file specifying preload content)  
 DTAImage(1).TestClass=pdrvimg (Indicates process that will be used to preload)  
 20 CPU(1).DESC=INTEL P3  
 CPU(1).OPERATION=CPL-KIT  
 CPU(1).BOM\_PN=09N9215  
 CPU(1).TESTCLASS=cpu  
 CPU(1).SPEED=667\_MHZ (CPU information (for SW verify))  
 25 CPU(1).BUSSPEED=133\_MHZ (CPU information (for SW verify))  
 CPU(1).L1CACHE=32\_KB (CPU information (for SW verify))  
 CPU(1).L2CACHE=256\_KB (CPU information (for SW verify))  
 CPU(1).SMBIOSTYPE=11 (CPU information (for SW verify))  
 CPU(1).SMBIOSDESIGNATION=CPU1  
 30 MEM(1).DESC=128MB DIMM  
 MEM(1).OPERATION=CPL-KIT  
 MEM(1).BOM\_PN=38L2818  
 MEM(1).TESTCLASS=memory  
 MEM(1).SPEED=60\_NS (Memory information (for SW verify))  
 35 MEM(1).SIZE=128\_MB (Memory information (for SW verify))  
 MEM(1).ECC=NO (Memory information (for SW verify))  
 MEM(1).SMBIOSTYPE=3 (Memory information (for SW verify))  
 FDD(1).DESC=1.44MB FLOPPY  
 FDD(1).OPERATION=UNIT-ASM  
 40 FDD(1).BOM\_PN=TSFD001  
 FDD(1).TESTCLASS=fdd  
 FDD(1).CAPACITY=1440\_KB (FDD information (for SW verify))  
 FDD(1).PICTURE()=3



PICTURE(3).FILE=FLOPPY.JPG  
 PICTURE(3).DESC=FLOPPY DRIVE  
 IDE(2).DESC=20.4GB IDE HDD  
 IDE(2).OPERATION=KITTING  
 5 IDE(2).BOM\_PN=09N0922  
 IDE(2).TESTCLASS=hdd\_ide  
 IDE(2).CAPACITY=20.4\_GB  
 CABLEIDE(1).SCHEMATIC()=3  
 SCHEMATIC(3).DESC=IDE Cable  
 10 SCHEMATIC(3).FILE=IDECbl1.jpg  
 CONNECTORIDE(1).SCHEMATICOFFSET=empty  
 CABLEIDE(1).DESC=1 DROP IDE CABLE  
 CABLEIDE(1).OPERATION=KITTING  
 CABLEIDE(1).BOM\_PN=33L3132  
 15 CABLEIDE(1).PICTURE()=4  
 PICTURE(4).DESC=IDE Cable  
 PICTURE(4).FILE=IDECable.jpg  
 CABLEIDE(1).CONNECTORIDE()=1  
 CABLEIDE(1).CONNECTORDEVICEFILLIDE=HDDIDE  
 20 CABLEIDE(1).CONNECTORFILLIDE=10  
 CABLEIDE(1).CONNECTORLOCIDE=NO  
 CONNECTORIDE(1).LOCATORTEXT=IDE 1  
 CONNECTORIDE(1).SETUPIDE=MASTER  
 CABLEIDE(2).SCHEMATIC()=4  
 25 SCHEMATIC(4).DESC=IDE Cable  
 SCHEMATIC(4).FILE=IDECbl2.jpg  
 CONNECTORIDE(2).SCHEMATICOFFSET=empty  
 CONNECTORIDE(3).SCHEMATICOFFSET=empty  
 CABLEIDE(2).DESC=2 DROP IDE CABLE  
 30 CABLEIDE(2).OPERATION=KITTING  
 CABLEIDE(2).BOM\_PN=37L5001  
 CABLEIDE(2).PICTURE()=5  
 PICTURE(5).DESC=IDE Cable  
 PICTURE(5).FILE=IDECable.jpg  
 35 CABLEIDE(2).CONNECTORIDE()=2:3  
 CABLEIDE(2).CONNECTORDEVICEFILLIDE=HDDIDE,DVDIDE,CDIDE,TAPEIDE,ZI  
 PIDE  
 CABLEIDE(2).CONNECTORFILLIDE=30,40  
 CABLEIDE(2).CONNECTORLOCIDE=NO  
 40 CONNECTORIDE(2).LOCATORTEXT=IDE 1  
 CONNECTORIDE(2).SETUPIDE=MASTER  
 CONNECTORIDE(3).LOCATORTEXT=IDE 2  
 CONNECTORIDE(3).SETUPIDE=SLAVE

PCI(2).DESC=LAKE CLARKE 2.4 ETHERNET CARD W AOL

PCI(2).OPERATION=KITTING

PCI(2).BOM\_PN=34L1199

PCI(2).TESTCLASS=lake\_clarke

PCI(2).VENDORID=8086

PCI(2).DEVICEID=1229

PCI(2).PICTURE()=6

PICTURE(6).DESC= LAKE CLARKE PCI ETHERNET CARD

PICTURE(6).FILE=ether.jpg

AGP(1).DESC=PCIVIDEO\_S3AGP4X

AGP(1).OPERATION=KITTING

AGP(1).BOM\_PN=09N1790

AGP(1).TESTCLASS=number9\_4X

AGP(1).VENDORID=5333

AGP(1).DEVICEID=8A22

AGP(1).VIDEOMEMORY=16\_MB

AGP(1).PICTURE()=7

PICTURE(7).DESC=S3 AGP Video

PICTURE(7).FILE=S3AGP2.jpg

POWER(1).DESC=POWER SUPPLY

POWER(1).OPERATION=UNIT-ASM

POWER(1).BOM\_PN=TSPTS001

POWER(1).TESTCLASS=PowerSupply

POWER(1).WATTAGE=145\_WATTS

POWER(1).CURRENT=20\_AMPS

POWER(1).VOLTAGE=115/220\_VOLTS

POWER(1).PICTURE()=8

PICTURE(8).DESC=Power Supply

PICTURE(8).FILE=Pwsup1.jpg

CONNECTORPCI(3).INSTALLEDDEVICE=PCI(2) (Indicates third pci connector gets second pci card)

PLANAR(1).SYSBIOSLANGUAGE=US (Indicates desired BIOS language)

CONNECTORFDD(1).INSTALLEDDEVICE=FDD(1) (Indicates first floppy drive is plugged on first floppy connector)

CONNECTORCPU(1).INSTALLEDDEVICE=CPU(1)

CONNECTORMEM(1).INSTALLEDDEVICE=MEM(1)

CONNECTORMEM(2).INSTALLEDDEVICE=EMPTY

CONNECTORAGP(1).INSTALLEDDEVICE=AGP(1)

CONNECTORPCI(1).INSTALLEDDEVICE=EMPTY

CONNECTORPCI(2).INSTALLEDDEVICE=EMPTY

CONNECTORCABLEIDE(1).INSTALLEDDEVICE=CABLEIDE(1)

CONNECTORCABLEIDE(2).INSTALLEDDEVICE=CABLEIDE(2)

CONNECTORCABLEFDD(1).INSTALLEDDEVICE=CABLEFDD(1)

CONNECTORPOWER(1).INSTALLEDDEVICE=POWER(1)

CONNECTORIDE(1).INSTALLEDDEVICE=IDE(2)

CONNECTORIDE(2).INSTALLEDDEVICE=IDE(1)  
 CONNECTORIDE(3).INSTALLEDDEVICE=EMPTY  
 BAYPLANAR(1).LOCATEDDEVICE=PLANAR(1) (Planar(1) is mounted in  
 BayPlanar(1))  
 5 BAYPOWER(1).LOCATEDDEVICE=POWER(1) (Power(1) power supply is  
 mounted in BayPower(1))  
 BAYFDD(1).LOCATEDDEVICE=FDD(1)  
 BAYHDD(1).LOCATEDDEVICE=IDE(2)  
 BAYDASD1(1).LOCATEDDEVICE=IDE(1)  
 10 BAYDASD2(1).LOCATEDDEVICE=EMPTY  
**Dynamic AOD Modification**

A key benefit of the AOD data model is that different processes in the fulfillment system  
 can add to or alter the AOD stream. Thus, as the customer selects certain devices and options, the  
 system can automatically generate AOD corresponding to proper configuration and population  
 15 rules. That information need not be provided at the time of order entry, but rather is determined  
 later during a post-order process that is transparent to the customer.

Figure 1 illustrates a product fulfillment system 10 in accordance with one embodiment of  
 the present invention. As is shown, a web based front end ordering system 20 allows the customer  
 to select from a wide range of configuration options. The ordering system may capture part  
 20 numbers requested and a small amount of personalization data, such as which PCI slots a customer  
 wants the cards installed in, and some network settings. The personalization data is referred to as  
 Customer AOD. The information obtained through the user interface is then passed into a Order  
 Processing System 30.

Here, the customer's product specifications are merged with population and configuration  
 25 rules to form an AOD data stream. Configuration and population rules are stored in a database  
 along with tables that associate part numbers to AOD; the part numbers have a one to one  
 correspondence with components, and define the objects, attributes and values. Because the Order  
 Processing System 30 has the ability to capture and convert the customer's specifications and

supplement that information to create an operable computer, the amount of information required from the customer is minimized.

The AOD data stream emerging from the Order Processing System 30 is referred to as the Process AOD 40. This AOD fully and accurately describes the customized product requested by the customer. The Process AOD 40 is used in the automated manufacturing system 50, which includes several processes. For example, the automated manufacturing system 50 can include processes for creating assembly instructions 52, a process for automated testing 54, a process for automatically loading software 56, a customization process 58, and quality control 60. In addition, a service and support process 62 can be incorporated into the system 50.

In a preferred embodiment, the automated manufacturing system's 50 processes can be software based. Each process understands and works off of the Process AOD 40. Because each of the processes 52-62 is specialized, the entire Process AOD 40 need not be transferred to each of the processes 52-62. A particular process, for example, the automated test process 54, can examine the Process AOD 40 and extract only those portions that are relevant to the test process 54 function. Accordingly, the amount of data transfer through the automated manufacturing system 50 is minimized.

In another embodiment, the assembly instructions process 52 uses the Process AOD 40 to create a pictorial form of the assembled product. For instance, instead of interpreting written assembly instructions, the assembly worker can be presented with a pictorial view of the device. This view can illustrate what particular components should be installed, how components should be connected, and where, i.e. which slot, a component should be placed. By presenting a picture of the assembled product, language barriers can be overcome, and worker confusion can be minimized.

Figure 2 is a flow diagram of a product fulfillment process 100 according to the present invention. In step 110, the process begins by obtaining the requirements, including configuration and personalized data, from the customer. This information is then used to create the Process AOD, via step 120. Step 120 is preferably an automated process which merges the information obtained from the customer with information stored in the database relating to configuration rules and population schemes. After the Process AOD is generated, it is used by the automated manufacturing system where the product is assembled, preloaded with software, and tested, via step 130. Finally, in step 140, the Process AOD is stored in a database for use by the service and support department to restore, repair, or replace hardware in the computer (e.g., correct BIOS levels, network settings, etc.).

The object oriented approach and data model according to the present invention provides the ability to capture customer inputs from an ordering system and to transmit them to the manufacturing process without manual intervention or retyping of a free form, text based, order. It allows customers to specify a wide range of requested configuration options at order entry time to satisfy the customer's requirements. The present invention captures the order information accurately and completely, eliminating the need for follow-up calls with the customer to ask additional questions or for clarifications.

The Process AOD provides a structured data format that can be used by all processes including ordering systems, manufacturing, assembly, manufacturing test, preload, quality, and service/support. Because of the modular nature of AOD, new products and components can easily be added to the system. Thus, rather than having to create and release a new model to specify new groupings of hardware, software, or other options, the object oriented data model allows a modular, building block approach. Finally, because customization and personalization data can be

accurately captured without requiring separate part numbers, the number of part numbers that must be released by a development team is reduced.

Although the present invention has been described in accordance with the embodiments shown, one of ordinary skill in the art will readily recognize that there could be variations to the  
5      embodiments and those variations would be within the spirit and scope of the present invention.

Accordingly, many modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims.